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Nozzle Plume Effects on Sonic Boom Using the Gulfstream Study Vehicle Design

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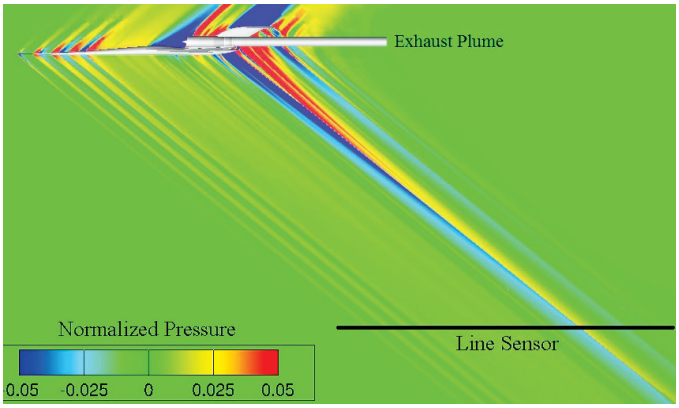
The disturbance caused by sonic booms of supersonic aircraft forced the FAA to ban supersonic flight over land. The FAA stated that any future supersonic airplane must produce no greater noise impact on a community than a subsonic airplane. This restriction made the reduction of sonic boom an important subject in the area of aeronautical research. Recent studies by NASA and Gulfstream Aerospace Corporation have demonstrated that sonic boom may be reduced to such a degree that the FAA is reconsidering the possibilities of civilian supersonic flight over land.

The ability to change the sonic boom signature of a supersonic aircraft by manipulating the shape of the exhaust plumes from the engines was examined using Gulfstream's supersonic study vehicle design. Using 3-D modeling software and computational fluid dynamics (CFD) codes, several exhaust nozzles were designed with varied internal geometry in order to produce different shapes of exhaust plumes. These plumes were then integrated onto the 3-D model of the entire vehicle, with the engines in varied locations, and analyzed by a CFD code yielding the near-field sonic-boom signatures. The comparison of these signatures to each other demonstrates that there is an interaction between the shape of the exhaust plume and the sonic-boom signature. This concept could provide valuable support in the effort to reduce the overall sonic boom of supersonic aircraft.

Research advisors Raymond Castner and Don Mueller write, "Research and design in the area of supersonic flow is complex and beyond the abilities of most undergraduate students. Michael's efforts directly contributed to the understanding of the impacts of the nozzle plume and various nozzle positions on the sonic-boom signature and to the identification of future analysis and test efforts."



CFD solution of Gulfstream's supersonic study vehicle design at Mach 1.6. Exhaust plume is simulated as an extruded solid body. The near-field sonic-boom signatures were extrapolated at the line sensor.

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